Can we assess the sense of smell through a face mask?

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Dear Editor,

The olfactory deficit is one of the most common symptoms of coronavirus disease 2019 (COVID-19): it affects 5 to 85% of patients with COVID-19 [1-3]. Therefore, the assessment of olfaction is of great importance because it contributes to the screening out and then isolating "asymptomatic" patients to prevent further disease transmission [2,4] . Compared with subjective reports and questionnaires used in the majority of studies [1,2,5], psychophysical measurements of olfaction provide less biased results and quantitative criteria for diagnosing olfactory deficits [4,6]. However, psychophysical measurement is not safe under the pandemic of COVID-19 because the coronavirus spreads through the respiratory tract. To reduce the risk of infection during testing, it may be advisable to ask the patient to wear a mask that covers the nose and mouth. However, it is unknown whether and to what degree wearing a mask affects the results of olfactory measurement.

The current study recruited twenty subjects with normal olfaction (age 27.8 ± 3.4 years, 10 males and 10 females) and 10 patients with an olfactory deficit (age 56.4 ± 17.0 years, 3 males and 7 females) and compared their odor sensitivity and odor identification, with and without surgical and N95 masks, using the Sniffin' Sticks test, which is based on an odor-containing felt-tip pen [7]. Surgical masks were used in the first experiment. The subjects underwent two identification tests (with or without a mask) after 2 sensitivity tests (with or without a mask). Furthermore, the subjects were equally and randomly divided into 2 groups, in which a test with a mask was performed first or later, respectively. After each session, the subjects had a 5-min break, and they verbally rated the average odor intensity in this session (scale from 0 to 10, with 10 indicating the strongest sensation). An N95 mask was used in the second experiment, in healthy subjects only, and the study design was the same as that in the first experiment.

The main results were as follows. First, wearing surgical masks reduced the odor sensitivity but not odor identification (Figure 1 and Table 1). **Second**, the normosmic and hyposmic subjects demonstrated similar patterns of olfactory changes with surgical masks (Figure 1). **Third**, a significant decrease in odor intensity ratings was observed when subjects wore surgical masks (Table 1). **Fourth**, the odor sensitivity with a mask was positively correlated with the respective intensity ratings. **Last**, the preliminary experiment with N95 masks indicated a strong decrease in odor perception, and none of the subjects were able to finish the assessment of odor sensitivity and identification with an N95 mask.

As expected, the results of the present study suggested that wearing a surgical mask reduced the odor sensitivity and odor intensity ratings. Although odor molecules are small enough to pass through the surgical mask [8], the number of detected odor molecules may decrease because of the reduced airflow, and some molecules may be absorbed by the mask, leading to a decrease in olfactory perception, which becomes highly significant in the case of subtle odors. By contrast, for odor identification, no significant change was observed between the different conditions, with or without masks, even though the participants indicated a significant decrease in the odor intensity when wearing masks. Additionally, no significant association was found between the odor identification scores and intensity ratings, which was different from the association between the odor threshold test and respective intensity ratings. Certainly, the concentration of an odor in the identification test is much higher than that during threshold tests [7], allowing sufficient numbers of odorous molecules to reach olfactory receptor neuron (ORNs), despite the presence of masks. In addition, the odor identification test requires not only odor perception but also a cognitive function [9] and subjects may be able to compensate for their partial reduction of odor sensitivity. From a practical point of view, the present results suggested that odor identification was still possible even when the subjects wore masks, while an adjusted value (changed by approximately 2 points) should have been used when testing odor sensitivity with the Sniffin' Sticks test kit.

With N95 masks, many of the subjects reported that only for one-third of the pens used in odor identification, the odor could be perceived. None of the subjects could perceive the odor at the highest concentration in the threshold test. This finding suggested that the N95 mask is a strong odor barrier, and few molecules pass through the mask and reach ORNs. Therefore, the present results suggested that by impairing olfaction to various degrees, the N95 mask may serve as a possible model of anosmia in future olfactory experiments, while wearing a surgical mask, which only partially reduces olfaction, may be used as a model for hyposmia.

The current study also suggests that wearing face masks may affect or prevent the detection of COVID-19 symptoms [4]. Because the reduction in olfaction may go unnoticed when wearing a mask, people may overlook hyposmia as a possible symptom of COVID-19, which increases the possibility of disease transmission.

In summary, the assessment of olfaction, especially odor identification, is possible even when subjects wear surgical masks. Nevertheless, the results of odor sensitivity testing, but not of odor identification testing, with a mask have to be adjusted. Additionally, the use of surgical masks or N95 masks may serve as a model for hyposmia or anosmia, respectively.

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Table 1 Comparison of olfactory function with and without surgical mask in all subjcts

	Without mask	With mask	t	P	Cohen's D
Odor Threshold	10.1±4.6	7.7±5.0	4.04**	<0.001	0.510
Odor identification	12.4±2.1	12.1±2.5	1.20	0.239	0.178
Intensity of Threshold test	7.0±2.1	4.9±2.7	6.96**	<0.001	0.868
Intensity of identification test	8.7±1.7	7.3±2.0	3.48**	0.002	0.754

Figure 1 Change of olfaction with surgical mask in healthy and patients group.